The Nonactinide Isotopes and Sealed Sources Management Group (NISSMG) provides experienced technical personnel who implement innovative solutions using complexwide resources for site-specific issues.

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Nonactinide Isotopes and Sealed Sources Management Group

Fiscal Year 2001 Annual Report

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ACRONYMS

AEMP	Ashtabula Environmental Management Project
Am	americium
Ba	barium
Be	beryllium
BNL	Brookhaven National Laboratory
C	carbon
CAST	Condition Assessment Scoping Team
CBA	cost-benefit analysis
Cd	cadmium
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
Cf	californium
Ci	curies
Cm	curium
Co	cobalt
Cr	chromium
Cs	cesium
DOE	Department of Energy
DU	depleted uranium
EM	Office of Environmental Management
ETTP	East Tennessee Technology Park
Eu	europium
F	fluorine

F&ORs	functional and operational requirements
FEMP	Fernald Environmental Management Project
FGE	fissile gram equivalent
FY	fiscal year
Hg	mercury
INEEL	Idaho National Engineering and Environmental Laboratory
INMMP	Integrated Nuclear Materials Management Plan
Kr	krypton
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkley National Laboratory
LEU	low-enriched uranium
Li	lithium
LLNL	Lawrence Livermore National Laboratory
LTM	liquid technical materials
M	million
nCi/g	nanocuries per gram
NISS	nonactinide isotopes and sealed sources
NISSMG	Nonactinide Isotopes and Sealed Sources Management Group
NMFA	Nuclear Materials Focus Area
Np	neptunium
NTP	National Transportation Program
NTS	Nevada Test Site
NU	natural uranium

ORNL	Oak Ridge National Laboratory
OSRP	Off-Site Source Recovery Project
PNNL	Pacific Northwest National Laboratory
Pu	plutonium
Ra	radium
RFETS	Rocky Flats Environmental Technology Site
RTG	radioisotope thermoelectric generator
SNL	Sandia National Laboratories
SNM	special nuclear material
SPAR	special performance assessment required
Sr	strontium
SRS	Savannah River Site
TBD	to be determined
Tc	technicium
TMFA	Transuranic and Mixed Waste Focus Area
TRU	transuranic
U	uranium
UF_6	uranium hexafluoride
WET	Waste Elimination Team
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

Nonactinide Isotopes & Sealed Sources Management Group (NISSMG)

Complex–Wide Resources Solving Site Specific Problems

The Nonactinide Isotopes and Sealed Sources Management Group (NISSMG) [b] is sponsored by the Department of Energy (DOE) Office of Environmental Management (EM) and managed by the Albuquerque Operations Office to serve as a complexwide resource for the management of DOE-owned nonactinide isotope and sealed source (NISS) materials. NISS materials are defined as including any isotope in sealed sources or standards; and isotopes, regardless of form, with atomic number less than 90. The NISSMG assists DOE sites with the storage, reuse, disposition, transportation, and processing of these materials.

This report describes the activities of the NISSMG during fiscal year (FY) 2001. Since its inception in early in 1999, NISSMG has been successful in helping sites develop and implement material disposition plans for their NISS materials. During FY 2001, NISSMG supported numerous sites with a variety of services.

The Fernald Environmental Management Project, an EM closure site located in Ohio benefited from NISSMG support both in terms of deploying technologies to process and package select NISS materials quicker and with less potential risk to the workers, and in determining disposition paths for other NISS materials.

NISSMG developed comprehensive material management and disposition plans for Ashtabula in Ohio and Rocky Flats in Colorado. These plans provide a suite of disposition alternatives for all nuclear materials and NISS materials at Rocky Flats.

NISSMG helped active DOE sites and projects determine how to effectively and economically disposition their NISS and other nuclear materials. NISSMG evaluated nuclear materials that did not have disposition paths for the Pacific Northwest National Laboratory. This effort was part of the DOE EM Office Integration and Disposition (EM-20) "To be Determined" (TBD) project, which NISSMG supported. Other sites that NISSMG evaluated as part of the TBD project were the Idaho National Engineering and Environmental Laboratory and the East Tennessee Technology Park.

[b] The *Integrated Nuclear Materials Management Plan (INMMP),* required by Section 3172 of the FY 2000 National Defense Authorization Act, committed DOE to evaluate establishing Nuclear Materials Management Groups to manage nuclear materials as part of its multiyear agenda. The NISSMG is one of five nuclear materials management groups (Plutonium, Uranium, Heavy Isotopes, and Spent Nuclear Fuel are the others) created by the Deputy Assistant Secretary for EM's Office of Integration and Disposition (EM-20) to ensure nuclear material integration across the DOE nuclear materials complex. The DOE Albuquerque Operations Office manages the NISSMG.

NISSMG, in conjunction with the Nuclear Materials Focus Area (NMFA), sponsored a successful small sites workshop that brought together sites needing nuclear materials dispositioned with EM service providers that had potential solutions. NISSMG and NMFA will sponsor another small sites workshop in FY 2002.

NISSMG conducted a number of trade studies to evaluate disposition alternatives for a number of NISS materials and other nuclear materials, including radium, irradiated beryllium containing tritium, cesium and strontium, neutron sources, sealed source disposition at the Waste Isolation Pilot Plant, liquid technical materials, and classified parts. These trade studies were an efficient way to resolve complexwide issues using limited resources.

NISSMG developed a web-based "Virtual Source Bank" to help the DOE complex identify radioactive sources available for use at other DOE sites or programs. This application, as well as NISSMG reports and other information, can be found at http://emi-web.inel.gov/NISSMG.

NISSMG also supported closure facilities at non-closure sites, and was asked by Lawrence Livermore National Laboratory (LLNL) to provide assistance in closure activities for Building-251 (the Heavy Isotope Facility). "The manner in which NISSMG collaborated with staff at LLNL to produce the plan quickly after LLNL requested assistance last spring is exemplary. Most notable is that the plan provides a realistic disposition paths for more than 97% of the Building-251 inventory and identifies reuse or recycle options for over two thirds of the items. The NISSMG report also provided valuable insights into cost-effective management of Building-251 materials by showing that accelerating disposition of materials from the Building-251 has the potential to save more than $5 million over the baseline plan."[c]

The FY 2001 operations of the NISSMG confirmed the value of the material management group, focusing on a specific scope of materials and serving as a complexwide resource supporting the effective management of nuclear materials. With modest resources, the NISSMG demonstrated a substantial benefit through support of the following key EM activities:

- *Closure Site Support*—providing Fernald and Rocky Flats with thorough management and disposition options, as well as supporting the implementation of the selected alternatives

- *Trade Studies*—using an efficient methodology to produce solutions and decision making criteria for complexwide issues

- *Closure Facility Support*—resulting in shortened schedules and operational cost savings.

[c]Dennis K. Fisher, "Memorandum of Appreciation," to James O. Low. March 11, 2002.

1. NISSMG'S MISSION

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The Nonactinide Isotopes and Sealed Sources Management Group (NISSMG) is an integral component of the Department of Energy (DOE) Office of Environmental Management's (EM) Nuclear Material Stewardship program. The genesis of NISSMG began as the nonactinide and sealed sources (NISS) team in January 1998; one of three teams in the EM-60 Nuclear Material Integration project. In December 1998, the NISS team produced the first ever complexwide inventory and assessment for NISS materials. This inventory identified numerous issues and provided recommendations for effective management of NISS materials, especially at closure sites. In early 1999, the DOE Albuquerque Operations Nuclear Material Stewardship Program Office, under the sponsorship of EM's Office of Integration and Disposition (EM-20), initiated the NISSMG.

NISSMG enhances the effective management of NISS materials by providing direct technical support to closure sites and facilities to ensure timely stabilization and shipment of their NISS materials, thus reducing costs and accelerating schedules. NISSMG also develops effective mechanisms for reuse and recycle of NISS materials to implement DOE's pollution prevention strategies. By helping sites eliminate excess material inventories, NISSMG helps sites reduce the potential for loss of control of NISS materials, thus, enhancing worker and public safety. NISSMG helps sites reduce the costs of managing these materials by sharing knowledge and developing protocols for common NISS material activities. NISSMG priorities are to first serve DOE closure sites, then closure facilities at active DOE sites, and last but not least other DOE sites, as requested.

NISSMG supports the following key EM activities:[d]

- Improve safety performance.

[d] Jessie Roberson, Assistant Secretary for Environmental Management, Memorandum for Director, Office of Management, Budget and Evaluation, Chief Financial Officer, "Environmental Management Priorities," November 19, 2001.

- Reducing excess nuclear material inventories increases worker safety and reduces risk to the public.

- Reduce the cost and time required to complete the EM cleanup mission.
  - Provide direct support to the sites to develop nuclear material disposition alternatives and baselines.
  - Continue to provide technical assistance during implementation of disposition baselines.

- Close Rocky Flats, Fernald, and Mound[e] by 2006.
  - Actively work to remove nuclear materials from Rocky Flats and Fernald.
  - Provide proactive outreach to address small site issues.

- Consolidate nuclear material out of EM sites by 2004.
  - Resolution of orphan materials issues will be an essential element of the consolidation activity.

- Shrink the EM footprint.
  - Led discussions between the small EM sites and DOE service providers to enable them to close their nuclear material facilities.
  - Nuclear material removal is a major critical path item to subsequent decontamination, decommissioning, and environmental restoration. The NISS materials are often neglected in early planning. If the nuclear material disposition is not dealt with, then the EM footprint strategies become problematic.

NISSMG also addresses the issues typically associated with closure sites. These issues include loss of knowledge due to the retirement of Cold War Workers, and reduction of processing capacities for stabilizing and packaging nuclear materials for storage and shipment.

2. SCOPE

In general, NISSMG supports excess nuclear materials other than plutonium, uranium, and spent nuclear fuel. These materials include: nonactinide isotopes with an atomic number less than 90, regardless of form; all manmade isotopes in the form of sealed sources, standards, and research materials; and special categories such as radioisotope thermoelectric generators (RTGs), pacemakers, neutron sources, and a spectrum of orphan isotopes and activated materials at small

[e] NISSMG, *Mission Completed After 40-Year Delay*, June 2000.

sites (such as Fernald), regardless of the atomic number. NISSMG is helping DOE Headquarters and sites manage and disposition all NISS nuclear materials owned by EM with a significant integration role in the management and disposition of NISS materials owned by other DOE programs. NISSMG also has a role in assisting DOE with the management and disposition of excess DOE-loaned or leased materials at universities and in industry.

3. NISSMG'S SERVICES AND CAPABILITIES

3.1 Services

NISSMG has a core team of technical specialists available to help DOE sites that lack specific expertise for managing or dispositioning NISS materials. NISSMG cooperates with other EM material management groups, as needed, to provide sites with comprehensive disposition plans.

Typically, when a DOE site requests assistance, NISSMG provides technical specialists to assess the situation. From onsite assessments, NISSMG prepares a material management or disposition plan that outlines a suite of alternative solutions that can be applied to the problem. From that point, NISSMG assists the site in selecting the best site-specific alternative, considering the cost, schedule, and potential reuse application of the material. NISSMG can then aid the site in coordinating efforts to characterize, stabilize or treat, package, and transfer the material to its final disposition location.

NISSMG also approaches NISS management or disposal problems from a DOE complexwide perspective.

Products include:

- DOE site NISS material management or disposition alternatives
- DOE site NISS material management or disposition plans
- DOE complexwide NISS material management or disposition recommendations.

3.2 NISSMG Organization

NISSMG consists of a small core team networked with a larger virtual organization of both EM and non-EM technical experts. Most of the resources are devoted to technical specialists distributed around the complex. These technical specialists serve as resources to sites that lack specific expertise in managing or disposing of sealed sources, standards, and nonactinide materials. These technical specialists provide a means to sustain corporate knowledge in the life-cycle management of NISS materials. Figure 3.2-1 shows NISSMG's work breakdown structure in FY 2001.

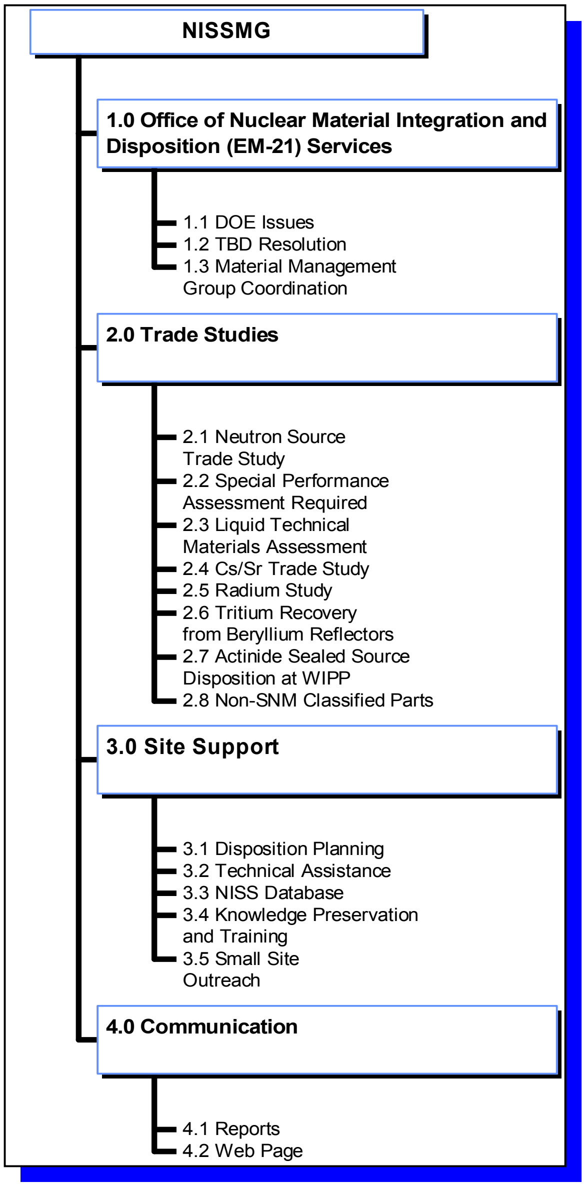

Figure 3.2-1. NISSMG FY 2001 work breakdown structure.

NISSMG coordinates a complexwide program providing technical and regulatory assistance for management and operational organizations in effective management of NISS materials. The program leads a concerted effort to use the existing DOE infrastructure to resolve materials issues and disposition NISS materials. NISSMG supports EM's technology research and development efforts by identifying developed technologies that can be used at multiple sites, and by optimizing technology investments.

Trade studies are conducted with site experts from across the DOE complex. These studies optimize alternatives, which result in life-cycle cost savings as compared to site-specific solutions. From the results of complexwide trade studies, NISSMG is able to recommend actions for addressing NISS material issues that are common across many DOE sites or have large potential impact. In addition, NISSMG maintains a comprehensive database of NISS materials to help the DOE complex accomplish reuse and effective management of NISS materials.

3.3 Economic Benefits

NISSMG used the DOE cost-benefit analysis (CBA)[f] methodology to estimate return on investment for NISSMG activities in FY 2001. Figure 3.3-1 shows the cost benefit process.

To measure the economic value of the assessments to sites, NISSMG applied the methodology developed by Haffner and Villegas.[g] Further discussion on NISSMG's economic analyses is provided in Appendix A.

Table 3.3-1 shows the potential cost savings for some sites by using NISSMG-developed management and disposition plans developed in FY 2001.

[f] Orman H. Paananen, Ph.D., Sandia National Laboratories, *Cost Benefit Analysis for Material Management Groups*, October 2001

[g] Haffner, D. R., and A. J. Villegas, *Technology Safety and Costs for Decommissioning a Reference Large Irradiator and Reference Sealed Sources*, NUREG/CR-6280, Washington D. C., January 1996

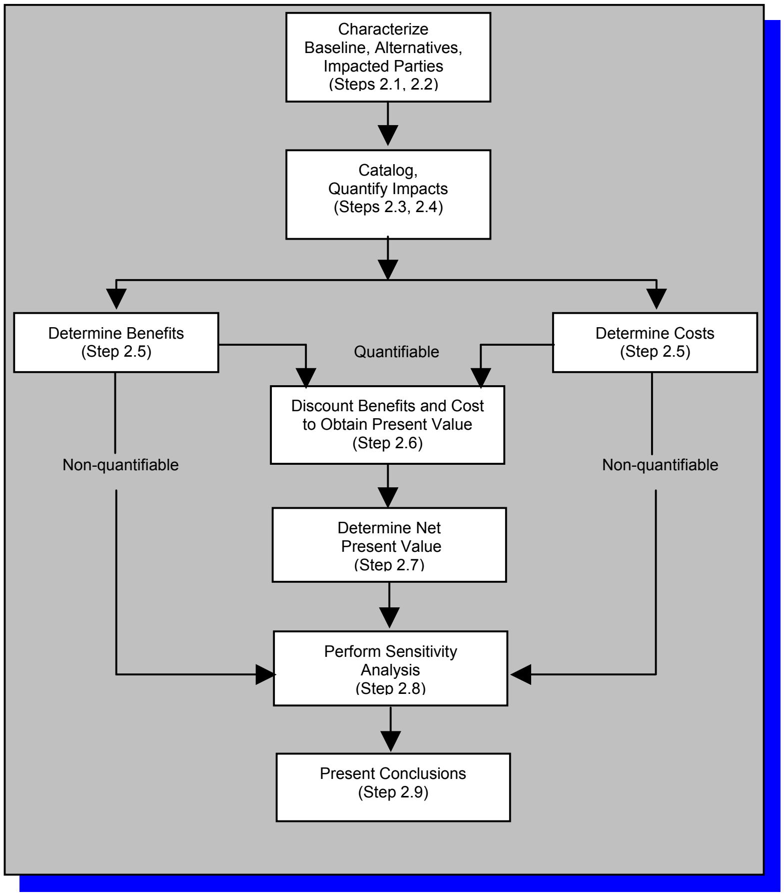

Figure 3.3-1. Cost benefit process

An example of a facility-specific economic analysis is Lawrence Livermore National Laboratory (LLNL) Building-251 (see Section 6.3). This economic evaluation was particularly useful in evaluating their disposition alternatives, and showed an economic benefit of over $5 million (M) by accelerating the building's deinventory schedule from 5 years to 2 years.

Through identifying better disposition options, NISSMG enables sites to better estimate their life-cycle costs for their baseline programs. Often the cost savings realized by using NISSMG are in disposal cost, schedule acceleration or both.

4. INTERFACES

NISSMG worked with a number of DOE organizations to aid active and closure sites in FY 2001. These included the Nuclear Materials Focus Area (NMFA), which manages nuclear material technology development; the

Table 3.3-1. Potential cost savings for some DOE sites.

Site	Cost Savings	
	Disposal	Reuse
AEMP[h]	357 items @ $800/item = $285,600	
PNNL[i]	100 items @ $800/item = $80,000	232 items @ $400/item = $92,800
LLNL[j]	160 items @ $800/item = $128,000	137 items @ $400/item = $54,800

- Some items were still in programmatic use, so there was no cost for reuse or disposal.
- Some items needed to be characterized further to determine if there were reuse options available. These items were divided evenly between reuse and disposal for this cost estimate.

[h] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan For Ashtabula*, July 2001.
[i] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan for Pacific Northwest National Laboratory (PNNL)*, June 2001.
[j] NISSMG, *Nuclear Materials Management and Disposition Plan for the Heavy Isotope Facility at the Lawrence Livermore National Laboratory,* September 2001.

Transuranic and Mixed Waste Focus Area (TMFA), which manages technology development for transuranic (TRU) and mixed waste; and the Off-Site Source Recovery Project (OSRP), which dispositions excess licensed nuclear sources.

4.1 Nuclear Materials Focus Area

The NMFA is an organization within the Office of Science and Technology (EM-50) that provides technology solutions for handling and disposing of nuclear materials, including spent nuclear fuel. In April 2000, the Ohio Field Office requested NISSMG support to develop a suite of disposition baseline alternatives for the Fernald Environmental Management Project (FEMP) materials.

NISSMG worked with Fernald to develop functional and operational requirements (F&ORs) for nuclear material handling, processing, and disposal. In 2001, these F&ORs provided the basis for acquiring onsite material handling and processing equipment. In addition, Fernald used this evaluation to rebaseline their program, thereby identifying enabling technologies that would allow them to disposition their difficult NISS materials. Figure 4.1-1 shows the Fernald F&ORs. These F&ORs identified needs for dealing with free radioactive liquids, transferring granular oxides possibly by vacuum, and remotely opening and venting drums. NISSMG and NMFA identified technologies under development that might be applied to these problems. In FY 2001, the NMFA worked with Fluor Fernald to deploy the porous crystalline matrix (Gubka),[k] and a vacuum transfer system[l] for transferring uranium oxide from storage containers to shipping containers, and to demonstrate a remote operated drum puncturing system.

4.2 Transuranic and Mixed Waste Focus Area

The TMFA is an organization within EM-50 that provides technology solutions for handling and disposing of TRU and Resource Conservation and Recovery Act mixed hazardous and radioactive waste (mixed waste). NISSMG and the TMFA have collaborated in the areas of disposing of nuclear materials that are also considered either TRU waste or mixed waste.

TMFA sponsors the Waste Elimination Team (WET). One of the areas where NISSMG and WET teamed was in the area of disposal contracts. WET has emplaced waste disposal contracts for such items as uranium chips, gas cylinders containing uranium hexafluoride (UF_6), and classified items. NISSMG evaluated these contracts as options when suggesting alternatives for dispositioning nuclear materials at Rocky Flats and LLNL Building-251.

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[k] D. A. Knecht, T. J. Tranter, J. Macheret (INEEL); A. Meyer, D. Yesso, T. Daniels (Fluor Fernald); A. S. Aloy, N. V. Sapozhnikova (V. G. Khlopin Radium Institute, Russia); A. G. Anshits, O. M. Sharonova (Institute of Chemistry and Technical Technology, Russia); A. A. Tretjakov (Federal State Unitary Enterprise "Mining and Chemical Combine," Russia); *Deployment of Porous Crystalline Matrix (Gubka) Technology for Stabilizing Radioactive Standard solutions at Fernald*, Presented at Waste Management 2002 Conference, Tucson, Arizona, February 2002.

[l] S. Kaushiva, C. Weekley (Fernald Environmental Management Project); M. A. Molecke, G. F. Polansky (Sandia National Laboratories); *Fernald Vacuum Transfer System for Uranium Materials Repackaging*, presented at Waste Management 2002 Conference, Tucson, Arizona, February 2002.

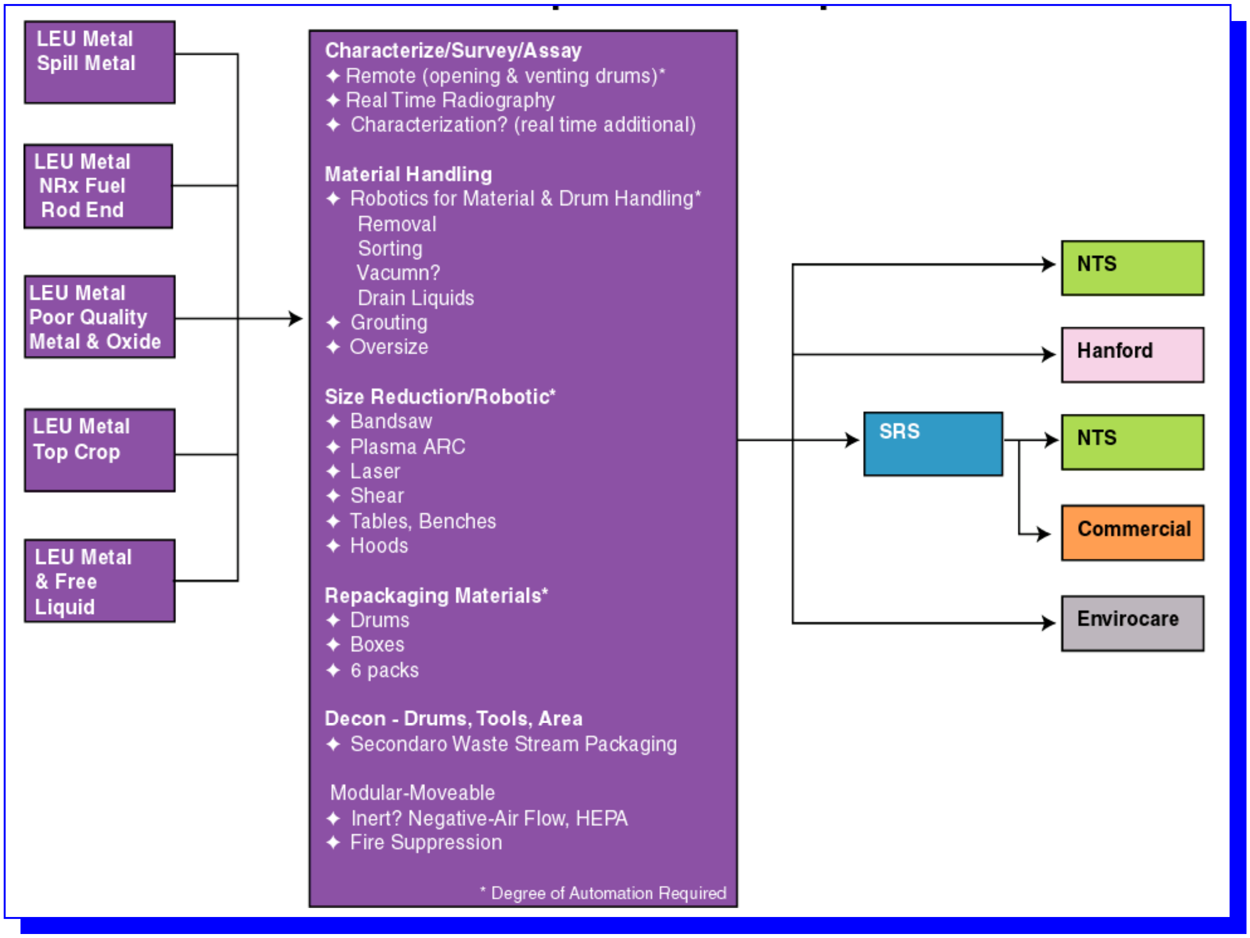

Figure 4.1-1. Fernald functional and operational requirements.

4.3 Off-Site Source Recovery Project

OSRP recovers and manages unwanted Nuclear Regulatory Commission-licensed radioactive sealed sources, radioactive materials, and greater than Class C waste. NISSMG uses OSRP as a neutron source disposal alternative. In FY 2001, NISSMG and the OSRP collaborated on a number of site-specific activities, including work supporting the Rocky Flats and Brookhaven National Laboratory (BNL) closure projects (see Sections 5.1 and 6.2, respectively), and the Neutron Source Trade Study (NSTS) (see Section 7.6).

5. CLOSURE SITE SUPPORT IN FY 2001

In FY 2001, NISSMG supported closure sites, including the Ashtabula Environmental Management Project (AEMP) and the Rocky Flats Environmental Technologies Site (RFETS), by evaluating their nuclear material disposition plans for their NISS materials, developing disposition plans for the material streams that did not have a path to disposition, and coordinating efforts to transfer the NISS material offsite. The NISSMG also continues to provide technical assistance to Fernald from their FY 2001 work.

5.1 Rocky Flats

In December 2000, NISSMG completed a comprehensive Material Management and Disposition Plan[m] for the Rocky Flats Environmental Technology Site (RFETS). The plan provided disposal options for all NISS material at RFETS. In FY 2001, RFETS began using the OSRP, one of the NISSMG alternates, for the disposal of neutron sources as TRU waste. RFETS needed to dispose of five neutron sources. NISSMG worked with the OSRP to remove these sources. Once Revision 21 of the Safety Analysis Report for Packaging for the Waste Isolation Pilot Plant (WIPP) is approved (in late summer 2002), the OSRP will package all of these RFETS sources in the S100 packaging system, which is approved for direct disposal to the WIPP.

5.2 Ashtabula

The DOE's Ohio Field Office asked NISSMG to provide technical support to the DOE staff at AEMP to baseline and determine the disposition of nuclear materials located on the site. The inventory consisted of 357 items.

NISSMG recommended that the nuclear material items be declared as waste and disposed of as low-level radioactive waste.[n] It also recommended that the low enriched uranium (LEU) and depleted uranium (DU) materials be consolidated into three drums: one drum for LEU oxide, one for LEU metal, and one for DU. Once this has been completed, each drum should be characterized for activity and isotopic content, and disposed.

5.3 Fernald

In FY 2000, NISSMG prepared a nuclear materials disposition plan for Fernald[o] to disposition 622 NISS material items at Fernald, of which 25 were active and still in use. NISSMG also developed functional and operation requirements for other nuclear materials at Fernald (see Figure 4.1-1). In FY 2001, Fernald used the disposition plans and the F&ORs to rebaseline the FEMP funding request to remove these materials from the site. Fernald will likely receive this requested funding and start additional removal activities in FY 2003.

6. ACTIVE SITE AND PROJECT SUPPORT

In 2001, NISSMG supported active sites and specific projects to determine how to disposition excess NISS materials. This effort included identifying disposition paths for materials that did

[m] NISSMG, *Rocky Flats Sealed Source Management Plan*, December 2000.
[n] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan for Ashtabula,* July 2001.
[o] NISSMG, *Fernald Sealed Source Disposal Plan*, September 2000.

not yet have disposition paths identified (these were referred to as "to be determined" or TBD) and specific site or facility support including dispositioning select sources for BNL, determining comprehensive disposition alternatives for "deinventorying" Building-251 at LLNL, and conducting a small sites workshop.

6.1 "To be Determined" Project

NISSMG was an integral member of EM-21's project to assess materials that had disposition paths with unknown or indeterminate steps. These unknown or indeterminate steps, regardless of the reason, are labeled as "TBD" (to be determined). The NISSMG personnel evaluated the potential disposition paths for a number of NISS materials and made recommendations for material disposition at the Pacific Northwest National Laboratory (PNNL), the Idaho National Engineering and Environmental Laboratory (INEEL), and the East Tennessee Technology Park (ETTP). The ultimate goal of these activities was to provide input to the comprehensive nuclear material management plan that would support EM's cleanup program.

After meeting with these sites, NISSMG developed a disposition plan for PNNL. The INEEL has a mature disposition plan, as the NISSMG had been advising them for three years. The ETTP did not have sufficient material characterization or inventory identification to be able to develop a disposition plan at this time.

6.1.1 Pacific Northwest National Laboratory

At EM-21's "To be Determined" Project for Material Disposition Mapping Workshop held in Richland, Washington, in March 2001, PNNL presented their draft baseline plan for nuclear material disposition. A number of concerns were raised on the disposition planning for these materials. As a result, the PNNL requested NISSMG's assistance in developing alternate management and disposition options.

NISSMG reviewed PNNL's baseline plans to understand the logic underlying their disposition strategy. NISSMG identified alternative paths to disposition these materials and beneficial reuse or recycle options for them. NISSMG determined that at the time there did not appear to be any timing considerations or facility closure issues that would drive the site or programmatic desire for disposition of certain NISS streams.[p] Most materials could either be reserved for special use at another site or disposed of at DOE disposal sites. Wherever possible, reuse and recycle were pursued rather than waste designation and disposal.

PNNL's inventory included: actinide sources such as americium, neptunium, uranium, thorium, and curium; orphan materials such as deuterium and lithium carbonate, beta-gamma streams of Co-60; and sealed sources such as plutonium/beryllium neutron and radium. For high purity

[p] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan for Pacific Northwest National Laboratory (PNNL),* June 2001.

NISS materials, NISSMG recommended that the Pu-238, Np-237, Am-241, and Am-243 be sent to the Oak Ridge National Laboratory (ORNL).

NISSMG identified a number of alternative disposition paths for PNNL's TBD NISS materials. Wherever possible, reuse and recycle were pursued rather than waste designation and disposal.

6.1.2 Idaho National Engineering and Environmental Laboratory

NISSMG visited with the INEEL in May 2001, to discuss their nuclear materials maps, particularly the material streams identified as TBD in their baseline disposition plan.

NISSMG identified that the INEEL neutron sources (for example, Cf-252) are large enough to be accepted by ORNL.

The INEEL has cesium sources stored inside 11 DU casks. NISSMG Cesium/Strontium and Special Performance Assessment Required (SPAR) trade studies (see Sections 7.3 and 7.1, respectively) considered these sources and similar inventories, and offered a disposition recommendation. As a result of the meeting, INEEL revised their disposition maps to ship the cesium to the Nevada Test Site (NTS) for low-level waste disposal.

6.1.3 East Tennessee Technology Park in Oak Ridge

A TBD site visit was conducted at Oak Ridge in July 2001. The ETTP materials were reviewed. Only a few of the NISS materials were accountable under material control and accountability (MC&A), and only limited characterization data were available. NISSMG and ETTP staff agreed it was premature to develop a material management and disposition plan. When this information becomes available the NISSMG and ETTP staff will collaborate on a definitive plan for management and disposition.

6.2 Brookhaven National Laboratory

BNL identified a 50-curie americium and beryllium neutron source that needed to be removed from its current location in the Building-445 yard. Removing this source was a critical path item for BNL to meet its commitment of downgrading the Building-445 yard from a nuclear material storage area to a radiological area, thus allowing the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) soil remediation action to begin as scheduled in FY 2002.

NISSMG recommended that BNL continue to work with the OSRP program for permanent disposal of the neutron source, and committed to identify interim storage options at other DOE sites that would allow BNL to meet its CERCLA commitment. NISSMG and OSRP collaborated to design a "special form" container that will allow the americium/beryllium neutron source to be shipped offsite.

NISSMG worked with the DOE Chicago Operations Office to determine the viability of interim storage at the Argonne National Laboratory-West in Idaho or at the Fermi Laboratory.[q]

6.3 Lawrence Livermore National Laboratory Building-251

NISSMG was asked by LLNL to assess the feasibility of accelerating the disposition of nuclear materials from Building-251 (Heavy Isotope Facility) at LLNL. The new schedule would be to deinventory Building-251 to radiological facility levels (per DOE Standard 1027[r]) by April 2003, as compared to 2006. Accelerating the disposition of these materials reduces cost, increases safety, and returns unique and valuable radioactive isotopes to beneficial use. A previous LLNL study[s] recognized these benefits, but also acknowledged that no clear disposition path existed for most of the materials. Figure 6.3-1 shows storage inside Building-251.

NISSMG reviewed inventory data and categorized the Building-251 materials into 62 disposition streams.[t] Then they defined disposition alternatives. There is high confidence in the proposed dispositions options for 97% of the categorized disposition streams. Some of the material will require additional characterization to establish recommended disposition streams and plans

The NISSMG plan demonstrated that removal of the nuclear materials from Building-251 could proceed much more rapidly than LLNL staff had originally projected. Cost estimates show the potential cost savings for an accelerated deinventory to be $5M over a 3-year period. This cost savings estimate does not take credit for the value of the rare and unique materials in the

Figure 6.3-1. LLNL Building-251 material storage.

[q] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management Group Brookhaven National Laboratory – 50-Curie Neutron Source*, Draft, June 2001.
[r] DOE Standard 1027, September 1997, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," U.S. Department of Energy.
[s] LLNL, Condition Assessment Scoping Team (CAST), *Building 251 Condition Assessment, Options, and Recommendations: Final Report*, February 2001.
[t] NISSMG, *Nuclear Materials Management and Disposition Plan for the Heavy Isotope Facility at the Lawrence Livermore National Laboratory*, October 2001

Building-251 inventory that could be returned to beneficial use as a part of the deinventory process.

A CBA was performed to determine what cost savings could be realized from using the NISSMG alternatives. The expected net discounted cost savings of the NISSMG deinventory support alternative, based on the cost estimates for deinventory without and with NISSMG support, was approximately $5M in FY 2001 dollars. The estimate of the cost of NISSMG support activities was small at 1.5% of the projected cost avoidance. Based on these cost estimates, the proposed deinventory plan with NISSMG support would produce net benefits in the form of nearly 30% project life cost avoidance to DOE over deinventory without NISSMG support.

NISSMG continues to provide technical assistance to LLNL to resolve ongoing issues and support plan implementation.

6.4 Small Sites

During its support of DOE sites, NISSMG and NMFA have jointly observed widely varying capabilities in the ability to manage nuclear materials. The sites with more difficulties managing these materials are primarily the closure sites and small sites. NISSMG has focused most of its efforts on closure sites, specifically Mound, Fernald, Rocky Flats, and AEMP. Given the preponderance of issues with DOE sites holding large inventories of nuclear material, sites with smaller holdings may not be adequately understood and supported in their management of nuclear materials.

To increase their technical assistance to small sites, NISSMG and NMFA jointly teamed with other EM-based service providers to conduct a workshop for DOE sites with small nuclear material inventories (referred to as small sites). The first Small Sites Needs Workshop was conducted in September 2001. The workshop objective was to assist smaller DOE sites with nuclear materials issues by sponsoring a forum where they could be exposed to a broad range of service providers within the DOE complex. Figure 6.4-1 shows the sites that attended the Small Sites Workshop.[u]

Before the workshop, most sites were not coordinating with other sites trying to solve common problems, and many sites had not established baseline disposition paths for excess nuclear materials. Sites did not perceive the large costs or risks associated with storing excess nuclear materials and did not believe it was imperative to eliminate excess material. Consequently, only a few sites had made any significant efforts to identify and eliminate excess nuclear materials. Of particular concern were the small closure sites, where resources were being expended to develop expertise to determine disposition pathways for nuclear materials. The disposition of nuclear materials had already impacted the critical path for closure at the Mound Site. If actions were not taken, the same result could occur at other closure sites.

[u] NISSMG and NMFA, *Joint NISSMG and NMFA Small Sites Needs Workshop,* October 2001.

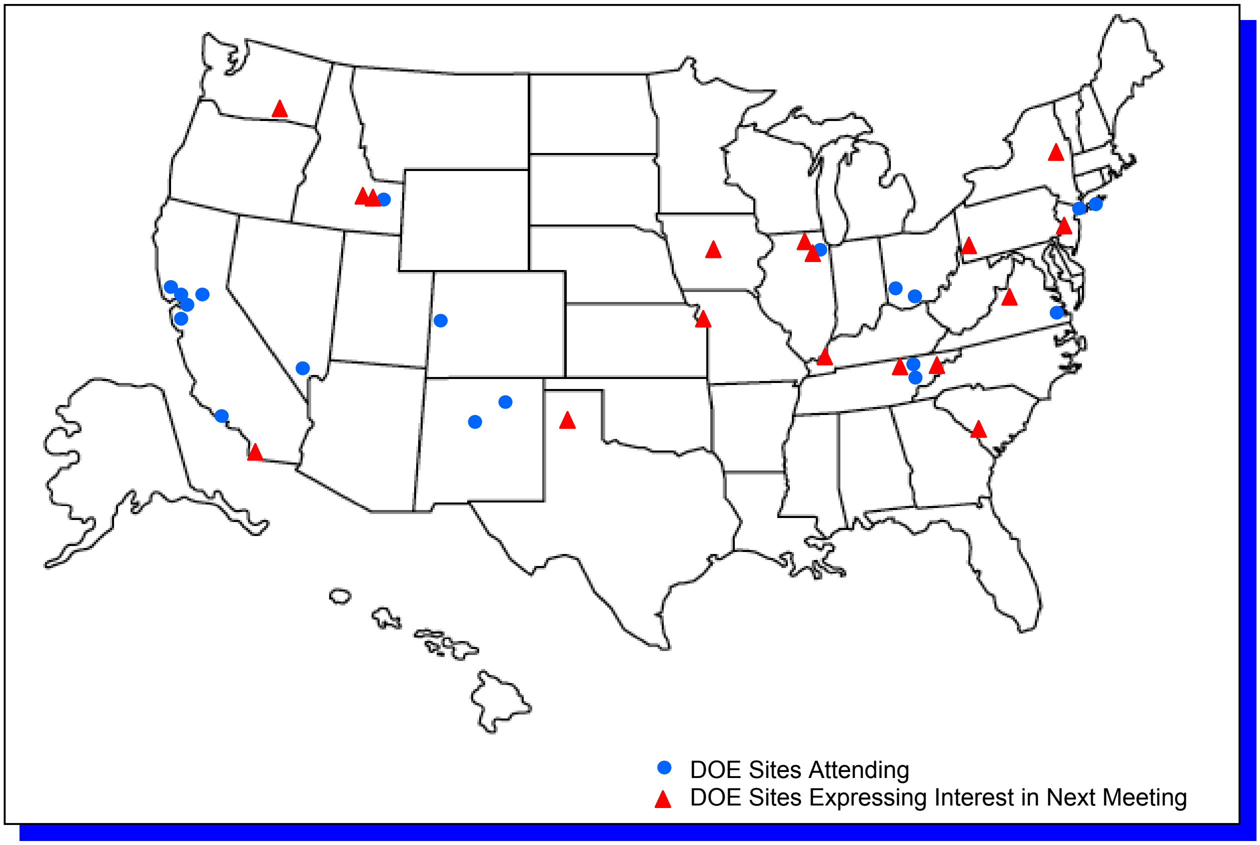

Figure 6.4-1. Small sites that attended the Joint NISSMG and NMFA Small Sites Needs Workshop.

At the workshop, sites interacted one-on-one with the service providers to discuss their specific needs in more detail. By the end of the workshop, they identified 49 specific site needs and service provider capability matches.

A small sites needs assessment report, with an analysis of the workshop data, will be completed in FY 2002. Nearly all of the sites that could not attend the first workshop mentioned that they would attend a future one, and several sites in attendance at the first workshop stated that they would attend a future one to keep current.

7. TRADE STUDIES

Trade studies are an efficient way to study complexwide issues using limited resources. NISSMG conducted the following trade studies in FY 2001:

- A study to determine how to discard NISS materials considered as "special performance assessment required" in order to dispose as low-level waste (phase I of this study defined the number of problem materials)

- An economic evaluation on recovering tritium from beryllium reflector blocks,
- Disposal of items containing cesium and strontium
- Disposal of classified parts
- Sealed source disposition at WIPP
- Reuse avenues for radium items
- A study on a method for determining appropriate disposition paths for neutron sources.
- A study to determine disposition paths for liquid technical materials (LTM)

The following sections describe the trade studies that NISSMG supported during fiscal year 2001.

7.1 Special Performance Assessment Required Study

NISSMG completed Phase I of a study[v] to identify NISS materials in the DOE complex that have the potential to be disposed of as low-level radioactive waste, but require exceptions to the established waste acceptance criteria for disposal (sometimes referred to as "special performance assessment required" or "SPAR" materials). Because the waste acceptance criteria for a disposal site are intentionally conservative to accommodate a wide range of materials, disposal site operators have the flexibility to accept, on a case-by-case basis, materials that exceed specific waste acceptance criteria requirements, but which can be disposed of while remaining within regulatory limits for the site.

NISSMG identified 392 nuclear material items authorized for the generator site that would not meet the waste acceptance criteria for the disposal site. Figure 7.1-1 is an aerial view of a waste disposal facility at NTS.

Based on funding availability, in Phase II of the study, NISSMG will work with DOE generators and NTS and Hanford disposal facilities to establish an institutional framework and methodology to enhance the efficiency of the waste acceptance criteria exception process. Following development of the methodology, candidate materials will be selected to exercise the process for disposal at NTS. Following successful disposal at NTS, lessons learned should be incorporated into the methodology. The institutional framework and methodology would then be made available throughout the DOE complex.

[v] NISSMG, *Special Performance Assessment Required Trade Study Interim Report - An Assessment of Excess Nonactinide Isotopes and Sealed Source Nuclear Materials at Department of Energy Sites Authorized to Use the Nevada Test Site and Hanford Low-Level Waste Disposal Facilities That Will Need Exceptions Prior to Disposal,* October 2001.

Figure 7.1-1. Aerial view of a waste disposal facility at the Nevada Test Site.

7.2 Feasibility of Tritium Recovery from Beryllium Reflectors

Reactors at INEEL and ORNL use beryllium reflectors as an internal framework structure because of beryllium's favorable physical and nuclear properties. Periodically (nominally every 8 years), these reflectors are changed out because the beryllium swells and becomes embrittled by the generation of gases within the component. Although there are no recycle or reuse options for the irradiated beryllium in the reflectors, they contain potentially recoverable quantities of tritium used in defense and commercial applications.

NISSMG determined that it was not cost beneficial for the government to recover the tritium in the beryllium reflectors at the current market price. [w] The cost of tritium would have to increase 10 times to provide any significant return on investment. Table 7.2-1 shows the cost comparisons. Upon removal from the reactors, the beryllium reflectors are waste with no potential for reuse or recycle. The disposal of these blocks resides within DOE's waste management system.

Table 7.2-1. Economic analysis of recovering tritium from irradiated beryllium reflectors.

	Amount	Total Cost
Commercial value of tritium for blocks on hand now	774,000 Ci at INEEL 400,000 Ci at ORNL	=$2,322,000 =$1,200,000 =$3,522,000
Commercial value of tritium for blocks coming out the reactors in the future	~4,644,000 Ci at INEEL 2,400,000 Ci at ORNL	=$18,552,000 =$9,600,000 =$28,152,000
Total Value		**=$31,674,000**
Cost to transport Advanced Test Reactor blocks to SRS	80 blocks and 115 cylinders at INEEL	=$20,600,000
Cost to transport High Flux Test Reactor blocks to SRS	36 blocks at ORNL	=$7,200,000
Upgrade to TIF		=$180,000,000
Cost of processing	7 campaigns (one initial to do the backlog and then every 8 years)	=$154,000,000
Total Investment		**=$361,800,000**
Return on Investment		**~ 0.2 %**

[w] NISSMG, *Management of Irradiated Beryllium Reflectors Containing Tritium*, October 2001.

7.3 Cesium and Strontium Items

Throughout the DOE complex, there are more than 70,000,000 curies (Ci) of separated cesium and strontium materials. The vast majority was separated from the Hanford high-level waste to reduce the heat load on the tanks and stored in capsules at the Hanford Waste Encapsulation and Storage Facility. There are also 1,482,506 Ci located in irradiation sources and RTGs at ORNL. (See Figure 7.3-1.) The remaining inventory is distributed among 21 other sites within the DOE complex. This dominant distribution of inventory at one site was a primary consideration in the development of potential alternatives for ultimate disposition of the inventory. NISSMG performed an evaluation of these cesium/strontium materials[x] to determine if programmatic changes in material management would result in:

- A reduction in risk to workers, the public, or the environment
- A reduction in the cost of maintaining the inventory
- A reduction in the number of facilities for the material.

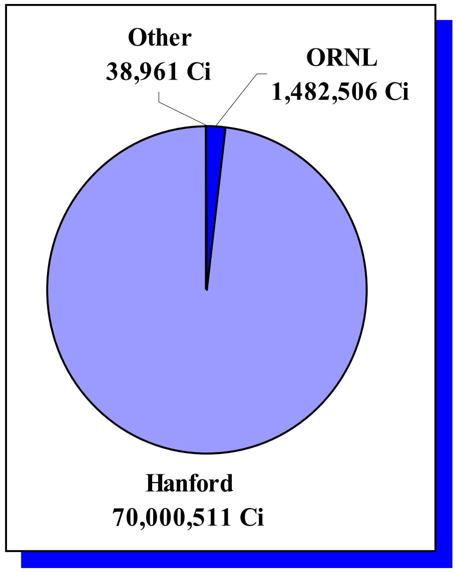

Figure 7.3-1. DOE's cesium/strontium inventory (Ci)

The fundamental approach in the study was to define and evaluate alternatives with respect to the ultimate end state of the material. The three defined end states of the material were high-level waste disposal, low-level waste disposal, and potential reuse. The goals defined for this study include reduction of risk, cost savings, mortgage reduction, and potential for reuse.[y]

Table 7.3-1 summarizes the normalized scores for the nine discriminating criteria used to evaluate the five alternatives in the decision analysis. Also considered in the development of the

Table 7.3-1. Cost summary for the five decision alternatives.

Category	Alternative				
	1 Baseline	2 Consolidation for Disposition	3 National Resource Consolidation	4 Existing Facility Utilization	5 Disposition Before Consolidation
Disposition Time (Years)	30*	25	25	20	25
30-Year Lifecycle Cost ($ Million)	$224	$281	$355	$319	$281

* 99% of the material is dispositioned in 20 years; the remainder is TBD.

[x] NISSMG, *Cesium-Strontium (Cs/Sr) Management Alternatives Trade Study*, July 2001.

cost analysis were potential savings resulting from closure of facilities or downgrade in nuclear facility status.

The cesium/strontium study did not identify any regulatory or policy drivers requiring changes in the current management of the cesium/strontium inventory, or any significant opportunities to improve on the current management of the inventory. The results showed that the Baseline (1) alternative, scored the best and was the lowest cost alternative, making it far-and-away the best alternative. The decision to select Alternative 1 as the recommended path forward resulted from an evaluation of the scoring with respect to the goals established for this study.

7.4 Radium

DOE has a number of closure sites that must remove the radium at their sites as part of their closure activities. NISSMG inventoried 654 radium-containing items totaling 22.5 Ci at 22 sites. One third of the items consisted of sources. Based on the curie amount, BNL, Los Alamos National Laboratory (LANL), and Argonne National Laboratory-East have the most radium. Based on the number of items, Fernald, NTS, and Lawrence Berkley National Laboratory (LBNL) have the most radium.[z] Figure 7.4-1 shows a box containing Ra-226 sources.

Because of other more practical sources, the need for radium sources and materials has declined. As such, NISSMG could not identify any demand for the radium, particularly in the DOE complex. As alternatives to disposal, there may exist reuse options for radium, especially in nuclear medicine. The most promising new development was the attention given to radium for cancer therapy applications, particularly Ra-223. Some recent DOE-sponsored research[aa] was encouraging, but there remains little ongoing work. NISSMG recommended that DOE set up receiver sites to store these radium materials until reuse options become available.

Figure 7.4-1. Ra-226 sources.

NISSMG recommended two pathways for dispositioning radium sources, depending on the activity and volume of material. High activity radium sources would be more

[y] This study is currently being reviewed by the "Top to Bottom" review team.

[z] D. L. Parks, E. C. Thiel, and B. R. Seidel, "Radium Disposition Options for the Department of Energy," Presented at the *Waste Management 2002 Conference, Tucson, Arizona, February 2002*.

[aa] D. R. Fisher, et al., "Dosimetry of Radium-223 and Progeny, ORISE—99-0164-Vol. #2, 375–391; Presented at the *Sixth International Radiopharmaceutical Dosimetry Symposium, Gatlinburg, TN, May 7–10, 1996*.

appropriate for reuse in nuclear medicine applications and other applications. The NISSMG suggested preserving the larger Ra sources that could easily be manufactured into targets for future reuse and disposing of the other items. Low activity radium sources could be managed as low-level waste per DOE Order 5820.2A.[bb]

The NTS's Waste Acceptance Criteria Working Group estimated that the total quantity of sealed sources (not just radium) in inventory was 500 ft^3, when prepared for final disposal. Based on an estimated average of NTS's waste generation volume of 500,000 ft^3 per year, this represented 0.1%, assuming all the sealed sources were disposed of in the same year (the radium sources are a small fraction of this amount).

7.5 Liquid Technical Materials

NISSMG conducted a study to examine the disposition options that sites with limited processing capabilities can employ to stabilize liquid technical materials (LTMs) and standards for storage and disposition. This problem is most relevant at closure sites and small sites where limited facilities exist. However, some large sites have expressed interest in disposition alternatives for these materials as they anticipate reducing their facility capabilities in the future. The study used a series of workshops to bring together site representatives with interest or experience in the treatment of these materials. Table 7.5-1 lists the sites that attended the workshops.

The workshops revealed that several sites, such as Sandia National Laboratories (SNL), AEMP, and the INEEL have well-established methods for dealing with LTMs. Several other sites have neither a baseline plan for the treatment and disposition of their LTMs, nor the knowledge or capabilities regarding disposition methods implemented at other DOE sites. A comparison of LTMs and their treatment methods at the INEEL, AEMP, and SNL indicated that the current suite of LTM treatment methods was successfully implemented for a variety of LTMs.

Table 7.5-1. Sites attending the Liquid Technical Materials Workshops.

Sites Surveyed for Liquid Technical Materials Assessment
1. Ashtabula Environmental Management Project
2. Rocky Flats Environmental Technology Site
3. Brookhaven National Laboratory
4. Idaho National Engineering and Environmental Laboratory
5. East Tennessee Technology Park
6. Lawrence Livermore National Laboratory
7. Fernald Environmental Management Project
8. Hanford Site

A portfolio of treatment options was assembled and high-level evaluations performed for cost, waste volume, and regulatory implications. Recognizing that there may not be a single optimum solution for all sites and materials, the final report will be arranged as a handbook that rates the most promising treatment options against the various performance metrics. An interim report[cc] was

[bb] DOE Order 5820.2A, August 20, 2001, "Radioactive Waste Management," U.S. Department of Energy.
[cc] NISSMG, *Liquid Technical Standards and Materials Management Assessment – Interim Report*, September 2001, Official Use Only.

completed in September 2001, which describes sites' inventories, issues, and some successful treatment methods.

7.6 Neutron Source Trade Study

NISSMG led a Neutron Source Trade Study, which included representatives from DOE Headquarters, sites and Operations Offices. The approach taken in this study was to establish a methodology for selecting appropriate disposition paths for these sources. First, existing reuse and disposal programs that might be or might become likely recipients of DOE neutron sources were identified. Acceptance criteria for these programs were researched and a sequential consideration of them was established, as shown in Figure 7.6-1. Sources not meeting the acceptance criteria of existing programs were identified as "Special Needs" material (i.e., sources above 28 Ci or nondefense TRU sources). A formal decision analysis was conducted for these sources to identify potential disposition alternatives.

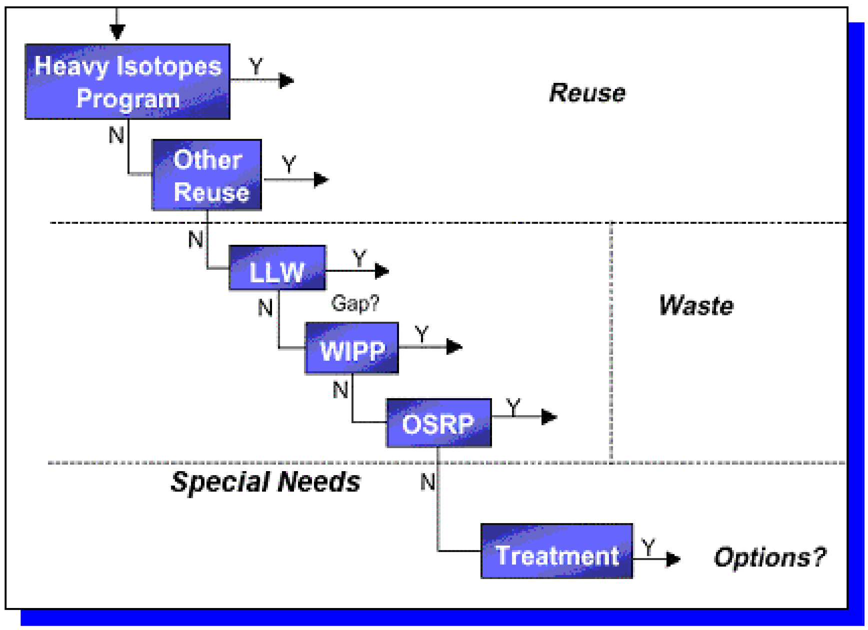

Figure 7.6-1. Neutron source disposition alternative selection process.

Four recommendations are made as a result of this study:

1. Reuse options for DOE neutron sources is recommended whenever possible. The resources of the Heavy Isotope Program and NISSMG should be used in identifying reuse options for these materials.

2. Direct disposal is recommended as the disposition path for excess, nonreusable DOE neutron sources.

3. Neutron sources that are nondefense TRU cannot be disposed of at present and should be stored until a viable disposition path for DOE nondefense TRU is established.

4. The development of a standard waste box as a container to both transport and dispose special needs neutron sources should be pursued. It is recommended that DOE begin the process to design, certify, and license this container.

Continuing work throughout the rest of the fiscal year resulted in a preliminary report in September 2001,[dd] and updating the NISS database with the new information on sources from the workshops.

7.7 Actinide Sealed Source Disposition at WIPP

The Office of Nuclear Material and Spent Fuel (EM-21) asked NISSMG to determine what the volume and activity would be if sealed actinide sources were to be disposed of at WIPP. DOE has various inventories of actinide-sealed sources that are currently excessed or planned to be excess to programmatic needs by 2015. These sources need to be dispositioned to enhance safety and reduce the infrastructure cost of maintaining the source inventory.

Even though the NISSMG inventory showed 7,510 sealed neutron sources and actinide sources, the study showed that this did not represent a substantial number of 55-gallon drums or a significant increase in the total amount of activity permitted in the WIPP performance assessment. The worst-case estimate of drums resulting from neutron and actinide sources was 274 drums and seven waste boxes. The study (see Appendix B)[ee] suggested that if Goal 3, Item 3 of the *National Transuranic Waste Management Plan*[ff] was implemented, the estimated number of drums and waste boxed was not a significant fraction of the total waste at WIPP.

7.8 Non-Special Nuclear Material Classified Parts

The DOE currently has inventories of radioactively contaminated classified weapons parts, molds, and tooling that were generated as a result of nuclear weapon research and development, production, and disassembly activities. This group of items is called non-special nuclear material (SNM) classified parts. Some estimates place the number of shells and molds at over 100,000 pieces, which is exclusive of the contaminated tooling that is also classified by virtue of shape.[gg] This inventory is stored at several DOE sites across the complex, including RFETS, an early closure site.

[dd] NISSMG, *A Methodology for Disposition of DOE Neutron Sources Report of the Neutron Source Trade Study Working Group*, draft, September 2001.

[ee] NISSMG, *Potential Actinide Sealed Source Disposition at WIPP (Draft)*, July 2001.

[ff] DOE National Transportation Program (NTP), *National Transuranic Waste Management Plan*, DOE/NTP 96-1204, Revision 2. Goal 3 is "Optimize TRU waste system operations." Item 3 is "Identify and evaluate alternatives to current treatment, characterization, transportation and disposal issues (e.g., centralized disposal characterization at WIPP)."

[gg] Richard Sena, memorandum, "Report on Preliminary Assessment for Disposition of Classified (Non-SNM) TRU Contaminated Weapons Parts and Process Equipment," August 4, 2000.

The level of TRU contamination on these items ranges from low level (less than 100 nanocuries per gram bulk [nCi/g-bulk]) to TRU levels (greater than 100 nCi/g-bulk). Furthermore, this inventory is not static. Activities associated with the proposed Pit Disassembly and Conversion Facility, pit manufacturing, and surveillance operations will result in the generation of additional contaminated, classified material. An optimal disposition path for the classified TRU material was needed.

A working group,[hh] led by NISSMG members, was formed in October 1999 to address some of the classified parts issues. The group targeted disposition paths for post-1970, TRU-contaminated, non-SNM classified parts. This material was maintained in retrievable storage around DOE sites and did not have a defined disposition path.

The working group used a methodology based on the identification of differentiating cost and programmatic risk factors among options. The assessment findings were:[ii]

- Direct shipment to WIPP appeared to be the most advantageous option if the legal issues were resolved

- Decontamination and consolidation at a single site appeared to be the least attractive option

- Because of site agreements at Rocky Flats, the continued storage option was not tenable.

WIPP has developed a DOE-Headquarters-approved security plan that covers parts and equipment incorporating classified information at the level of Secret/Restricted Data. Upon panel closure, the classified TRU waste can be declared to be irretrievably destroyed (by burial) and effectively sanitized.

The Acting Assistant Secretary for Environmental Management considered the working group's recommendation for implementation. The recommendation to authorize disposal of the Rocky Flats classified non-SNM without sanitization at WIPP, was approved on April 19, 2001.[jj]

Since Rocky Flats could dispose of their classified non-SNM parts at WIPP, this option could also be used by other sites needing to disposition classified TRU-contaminated items.

[hh] A. E. Whiteman, memo to distribution "Establishment of DOE Working Group on TRU Contaminated Non-SNM Classified Shells and Certain Pit Components," October 13, 1999.
[ii] Richard Sena, memorandum, "White Paper on RFETS Classified TRU Waste Interim Storage and Related Issues," December 4, 2000.
[jj] David Huizinga, Memorandum for the Acting Assistant Secretary for Environmental Management, "Action: Approve Recommendation for Disposal in the Waste Isolation Pilot Plant (WIPP) of Classified Waste Consisting of Transuranic (TRU) Contaminated Weapons Parts and Process Equipment From the Rocky Flats Environmental Technology Site (RFETS)," signed by Carolyn L Huntoon, April 19, 2001.

8. VIRTUAL SOURCE BANK

The NISS Web Application (Virtual Source Bank) is a web-based database query and data management tool designed to identify and potentially reuse radioactive sources throughout the DOE complex (see Figure 7.8-1). It provides search capability to the general Internet community and detailed data management functions to contributing site administrators. The NISS Web Application was conceived out of the Nuclear Materials Integration project, resulting in a 42,000 plus record database compiled by the NISS team.

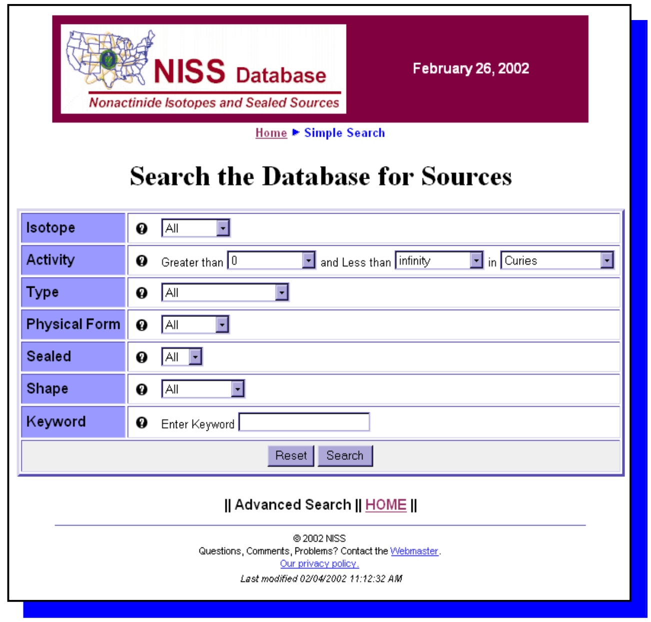

Figure 7.8-1. Virtual Source Bank web page.

NISSMG provides public access to the Virtual Source Bank from its web page at http://emi-web.inel.gov/nissmg/source_bank.htm and SNL issued a development report about the web application.[kk]

9. CONCLUSIONS

NISSMG FY 2001 operations continued to validate the concept of a material management group, focusing on a specific scope of materials and serving as a complexwide resource to effectively manage nuclear materials. With modest resources, NISSMG demonstrated a substantial benefit through its support of closure sites and closure facilities, as well as providing a suite of management alternates for nuclear materials as documented in NISSMG technical reports.

Fernald's use of the NISSMG material management plan as the basis for rebaselining their program clearly demonstrated the value of concise and accurate early planning. Additionally, integration and installation of enabling technologies identified in the FY 1999 and FY 2000 NISSMG studies have led to Fernald meeting or exceeding their programmatic milestones and developing a sealed source disposition plan for Rocky Flats.

Support of the EM-21 TBD Program identified disposition and reuse pathways for nuclear materials at Hanford, the INEEL, ORNL, and PNNL. In FY 2002, NISSMG and NMFA will again have a workshop on small sites. NISSMG's follow-on activities will be to help coordinate packaging and shipping of the nuclear materials identified in FY 2001 and to help develop disposition pathways for the sites that will participate in the FY 2002 workshop, if requested.

[kk] J. P. Fernandez, M. L. Jones, C. A. Ottinger, and C. A. Waldron, *Nonactinide Isotopes and Sealed Sources Web Application*, SAND2001-3960, Sandia National Laboratories, January 2002.

The development of a material management and disposition plan for LLNL Building-251, which provided reuse options for 67% of the items in inventory, is a significant accomplishment; however, when one considers the associated cost savings of $5M due to a 3-year acceleration of schedule and the increases in worker safety and safeguards and security, this effort becomes even more important.

In FY 2001, NISSMG continued to make progress in performing trade studies to address crosscutting issues for NISS materials in the DOE complex. A number of trade studies initiated in FY 2000 were completed, and several new studies were initiated. The information contained in these trade studies provides additional management and disposition alternates to the suite of options available for use in the disposition of these nuclear materials.

These trade studies are:

- *Special Performance Assessment Required*—This study identified nuclear materials in the DOE complex that should be disposed as low-level waste, but require exceptions to the established low level waste waste acceptance criteria.

- *Feasibility of Tritium Recovery from Beryllium Reflectors*—Reactors at the INEEL and ORNL use beryllium reflectors as apart of the internal framework. Although there is no recycle or reuse option for the irradiated beryllium in the reflectors, they contain recoverable quantities of tritium. The question of tritium recovery has always been one of economics. This study identified potential recovery technologies and evaluated the economics of their application. The study determined that it is not cost beneficial for the government to recover the tritium in the beryllium reflectors.

- *Cesium and Strontium Disposition*—This trade study evaluated the multitude of proposed disposition alternates based on the following criteria: reduction of risk, cost savings, mortgage reduction, and potential for reuse. The results conclude that the baseline alternative provides the optimal path forward at the lowest cost, making it far and away the best alternative.

- *Radium*—DOE has significant numbers of radium sources, standards and samples. These items must be disposed of at the closure sites. This evaluation recommended two pathways for disposition. Low activity radium sources can be managed as low-level waste per DOE Order 5820.2A.[ll] NISSMG suggests preserving the larger radium sources that can easily be manufactured into transmutation targets for future use or reuse in nuclear medicine applications.

[ll] DOE Order 5820.2A, August 20, 2001, "Radioactive Waste Management," U.S. Department of Energy.

- *Liquid Technical Materials*—These materials exist at all DOE sites and are problematic at closure sites and small sites where limited facilities exist. A portfolio of treatment options was assembled and high-level evaluations performed for cost, waste volume, and regulatory implication. Recognizing that a single optimum solution for all sites and materials was not likely, the final report will be arranged as a handbook that rates the most promising treatment options against the performance metrics. The interim report was completed in September 2001. The handbook will be completed as a FY 2002 activity.

- *Neutron Sources*—Neutron sources exist at all DOE sites. These sources are problematic because of the material type and because there are no disposal options for nondefense TRU materials. The interim report used a systematic approach to develop disposition alternatives and presented a suite of management options that ranged from reuse to direct disposal, and in some cases, interim storage for those materials with no defense pedigree. The final report, a neutron source disposition handbook, will be completed in FY 2002.

- *Actinide Sealed Source Disposition*—NISSMG evaluated the impact on WIPP. The evaluation concluded that, although the number of actinide sources and standards that exist in the complex is large (over 7,500 items), the impact on WIPP disposal capacity would be insignificant. The worst-case estimate resulting from direct disposal of these materials was 274 standard waste drums and seven waste boxes.

NISSMG Strategies

- **Identify and evaluate** alternative disposition paths for problem nuclear materials
- **Develop** disposition plans for site nuclear material inventories
- **Provide** technical assistance to closure sites in the implementation of disposal and reuse options
- **Assist** sites in securing funding to support disposal activities
- **Lead** complexwide evaluations of disposal/reuse options
- **Develop** site equity positions that utilize existing assets to solve complex wide material needs
- **Initiate, coordinate and assist** sites in obtaining assistance from other DOE programs

NISSMG provided other services to the DOE, other than trade studies and site support. One of these was the Virtual Source Bank, which is a web-based database query and data management tool for radioactive sources throughout the DOE complex. In FY 2001, the software application was completed, and the population of the data fields was started. This system will come online as a FY 2002 deliverable. Another service was the NISSMG web site, which came on line in FY 2001.

NISSMG had success in providing and implementing solutions for nuclear material issues at selected sites. However, nuclear materials exist at all DOE sites in a variety of isotopes, in many physical and chemical forms, and at various activity levels. Due to the diverse nature of these materials, issues often remain until the final disposition end state is achieved. Additionally, issues will need to be addressed at each site for each material form. Table 9-1 presents the material streams with issues still being resolved while implementing the detailed NISSMG management and disposition plans, and the unresolved material issues at those sites with limited NISSMG support interactions.

The concept of the NISSMG operating as a virtual organization, with a small core team of permanent members and a large resource pool from across the DOE complex and private industry, continues to be highly regarded. Core team members from the INEEL and SNL have drawn on the expertise of staff from the Argonne National Laboratory, Hanford, the INEEL, LLNL, ORNL, LANL, NTS, SNL and the Savannah River Site (SRS), as well as private industry contacts, to deliver its FY 2001 products. Cooperative efforts with DOE staff at operations and field offices have assisted in obtaining results. The lessons learned and experience developed in closure site and closure facility interactions have been captured and documented so that they can be shared with other sites experiencing similar problems. The success of NISSMG operations in FY 2001 continues to generate a number of additional requests for their support in FY 2002.

In the future, NISSMG will continue to support the closure sites. Some of the planned activities for FY 2002 include providing disposition planning for sites not yet analyzed, updating existing closure site plans in response to changes in site baselines or changes in dynamic nuclear materials infrastructure, and providing technical assistance to the sites in implementing the disposition plans. NISSMG also wants to continue to locate and draw on nuclear material expertise within the complex so that it has the capability to perform future trade studies in response to newly identified issues of loss of infrastructure.

Table 9-1. Sites with nuclear material issues.

Site	Material Streams with Issues	Quantity
RFETS	legacy sources	3200 items
	Ra-226	6 items
	Co-60, Cs-137, Sr-90	19 items
	Cf-250, Cf-252, Cm-244	62 items
	liquid technical materials	163 items
	Pu-238 standards	42 items
	Pu-239 standards	700 + items
	contaminated classified parts	——
	special items	12
	contaminated U ingots	——
	metal chips in oil	drums
FEMP	Ra-226	51 items
	liquid technical materials	~ 20 liters
	Am-241	56 items
	unassessed	400 items
AEMP	DU	63 items

Site	Material Streams with Issues	Quantity
PNNL	nondefense TRU	200 items
	Ra-226	2 items
Hanford	Pu-238	12 items
	Np-237	——
INEEL	Cs-137	11 items
	DU	10 items
	U solutions	5 liters
SRS	Am-241	30 items
	Cs-137	2 items
	Ra-226, Ra-226/Be	2 items
	Ba-133, Cd-109, Hg-203	104 items
ORNL	Cs-137, Sr-90	37 items
	Pu-238	6 items
	Pu-239	29 containers
	Ba-133, Cd-109, Hg-203, Cr-51	26 items
ETTP	Sr-90	——
NTS	classified TRU	——
	TRU	2500 drums & standard waste boxes
LANL	nondefense TRU	1000s of items
	Am/Cm	——
	C-14	3 items
	Np-237, Pu-240, Th-229	——
	Ra-226	3 items
	Cs-137, Sr-90, Co-60	27 items
	Am-241/F	2 items
	contaminated classified parts	——
SNL	Pu-239 ZPR	——
	DU	——
	Cs-137, Sr-90, Co-60	161 items
	Np-237	——
LLNL Building-251	Ra-226	——
	Co-57, Co-60, Cs-137	22 items
	Am-241	21 items
	U	26 items
	Pu-239/Sr-90 mixture	1 item
	Eu-152, Eu-154	2 items
	Ba-133, Cs-137, Co-60 mixture	1 item
	Kr-85	——
BNL	Eu-152	2 casks
	Am/Be	1 item
	Cs-137, Sr-90	2 items
	fission plates	12 items
Portsmouth	Tc-99	1000 drums
Ames Laboratory	Am/Li	——
	Pu-239/Be	——
	Cs-137	——

Site	Material Streams with Issues	Quantity
Kansas City Plant	U residues	8 drums
	drums mixed sources	2 drums
LBNL	natural uranium	——
	Pu-239 Residue	2 cubic meters
	Cf-250	10 + items
General Electric Vallecitos	spent nuclear fuel	
Argonne National Laboratory-East	fission plates	20 items
	Co-60	——
	sealed sources	——
Environmental Management Laboratory	sealed sources	700 + items
Thomas Jefferson Laboratory	Co-60, Cs-137	1 irradiator
	sealed sources	1 cask

APPENDIX A

ECONOMIC BENEFITS

APPENDIX A - ECONOMIC BENEFITS

As part of the evaluations that NISSMG performs to select possible alternatives to nuclear material disposition, the NISSMG often includes an economic evaluation. The economic analyses were in some cases quantified, in others provided a basis for estimated life cycle costs, and in others identified uncertainties. Early in FY 2001, the Nuclear Material Stewardship Program, including the NISSMG, began reviewing various cost benefit analysis (CBA) methods with emphasis on methods for quantifying benefits. Figure A-1 shows the cost benefit process. The purpose of the review was to investigate the potential to add further monetary benefit and cost measures to the cost avoidance calculations currently under way by NISSMG and other nuclear material management groups. The hope was that by using DOE methodology for CBA and recent research work on benefits measurement, NISSMG and others would have a clear basis for developing verifiable cost and benefit information.[mm], NISSMG used this approach to estimate return on investment (ROI) measures for NISSMG activities in FY 2001.

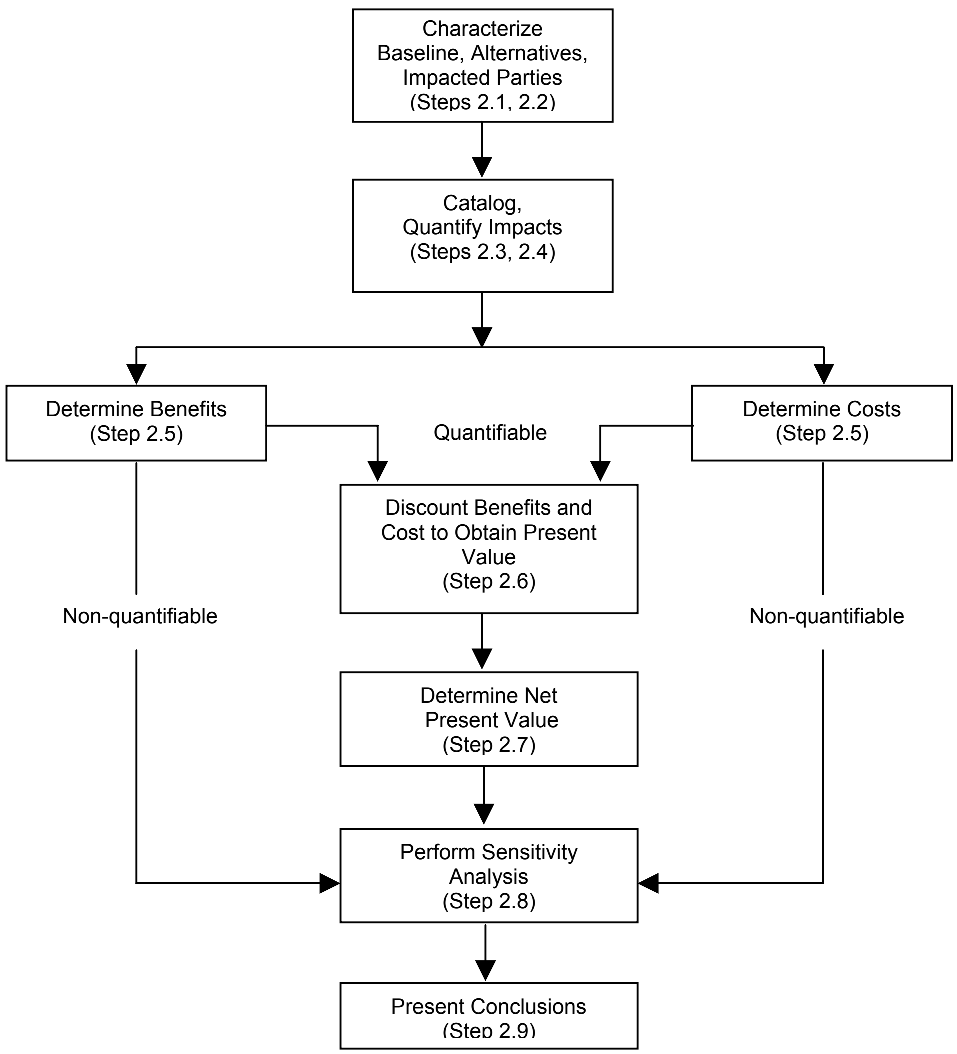

Figure A-1. Cost benefit process

[mm] Orman H. Paananen, Ph.D., SNL, *Cost Benefit Analysis for Material Management Groups*, October 2001.

Table A-1. Cost estimating relationship for each function in the disposal process for sealed sources.

Activity	Percentage (%) of Total Cost	Estimated Cost
Planning and Preparation	27 %	~$1,500
Miscellaneous equipment and supplies and packaging	11 %	~$ 600
Transportation	32 %	~$1,800
Disposal	30 %	~$1,600
Total	**100 %**	**~$5,500**

NISSMG worked with AEMP and PNNL to develop management and disposition plans for their NISS materials. The NISSMG reviewed site inventories, identified any significant barriers to effectively manage and disposition these materials and presented alternatives. To measure the economic value of the assessments to these sites the methodology developed by Haffner and Villegas[nn] was applied:

In their report, Haffner and Villegas provided a thorough discussion of the costs of disposal of sealed sources representative of those used in industry. They used a sequence of functions similar to those used in the DOE complex to move a source from its current status to ultimate disposition: planning and preparation, characterization, packaging, transportation, storage and disposal. The authors quoted all costs in 1993 dollars with a 25 % contingency. In order to bring the costs to 2002 dollars, the NISSMG used an escalation rate derived from the Economic Escalation Indices for DOE Construction and Environmental Management Projects. Using this as a basis, the estimated cost for disposal of sealed sources is about $5,500 per item. A further review of the Haffner and Villegas study established the cost estimating relationships for each function in the disposal process as shown in Table A-1.

Many sites perceive a lack of viable disposition options for these materials and most sites are not coordinating with other sites that are trying to solve common problems. These problems are most acute at closure sites such as AEMP. So the assistance provided by the NISSMG in the planning and preparation phase of the disposal process generally results in a 30 % reduction in planning activities at the subject site. Additionally, NISSMG assistance in the resolution of transportation issues usually results in a 15 % reduction in site costs.

Table A-2. Potential cost savings by using NISSMG expertise.

Task	Savings
Planning and Preparation	~$500/item
Transportation	~$300/item

Using these assumptions to quantify the saving by utilizing NISSMG expertise, potential cost savings can be established, as shown in Table A-2. The estimated cost saving to AEMP (which had no baseline plan for disposal) by utilizing NISSMG support is $261,000, as shown in Table A-3.[oo]

[nn] Haffner, D. R., and A. J. Villegas, *Technology Safety and Costs for decommissioning a Reference Large Irradiator and Reference Sealed Sources*, NUREG/CR-6280, Washington D. C., January 1996.
[oo] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan For Ashtabula*, July 2001.

Table A-3. Cost savings for some DOE sites.

Site	Cost Savings	
	Disposal	Reuse
AEMP	357 items @ $800/item = $285,600	
PNNL	100 items @ $800/item = $80,000	232 items @ $400/itme = $92,800
LLNL[pp]	160 items @ $800/item = $128,000	137 items @ $400/item = $54,800

- Some items were still in programmatic use, so there was no cost for reuse or disposal.
- Some items needed to be characterized further to determine if there were reuse options available. These items were divided evenly between reuse and disposal for this cost estimate.

The second assumption that can be drawn from these cost estimating relationships is potential cost saving by reuse of a given material. If the average cost to dispose of an item of NISS material is about $5,500, than an initial saving of about $4,000 likely can realized per item. The site will incur a cost of about $1,500 in planning and preparation to relocate this material to another DOE site.

At PNNL over 40 items did not have credible disposition paths before NISSMG prepared a management and disposition plan. This plan provided disposition alternates for over 42 items and reuse options for 208 items. The estimated potential cost savings at PNNL by utilizing the NISSMG plan are shown in Table A-3.[qq]

An example of a quantified economic analysis is the analysis that was done for the LLNL Building-251 (see Section 6.3). This economic evaluation was particularly useful in evaluating their disposition alternatives, and it showed an economic benefit of over five million dollars by accelerating a site's deinventory schedule from five years to two years.

Through identifying better disposition options, NISSMG enabled sites to better estimate their lifecycle costs for their baseline programs. Often the cost savings realized by choosing a different alternative than was in the original baseline, was in disposal cost savings, or in schedule acceleration.

Sometimes, the NISSMG provided information that could affect costs or schedules, but not directly. Some of the alternatives identified by NISSMG could enable a site or a facility to meet compliance baselines, whereas the baseline alternative did not. An example of this is where NISSMG showed Brookhaven National Laboratory (BNL) an alternative in which they could get their nuclear materials offsite to alternate interim storage locations, thus allowing them to meet their Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Tri Party Agreement.

[pp] NISSMG, *Nuclear Materials Management and Disposition Plan for the Heavy Isotope Facility at the Lawrence Livermore National Laboratory,* September 2001.
[qq] NISSMG, *Nonactinide Isotopes and Sealed Sources Material Management and Disposition Plan for Pacific Northwest National Laboratory (PNNL)*, June 2001.

APPENDIX B

POTENTIAL ACTINIDE SEALED SOURCE DISPOSITION AT WIPP

APPENDIX B - POTENTIAL ACTINIDE SEALED SOURCE DISPOSITION AT WIPP

The Department of Energy has various inventories of actinide sealed sources that are currently excess or planned to be excess to programmatic needs by 2015. These sources need to be dispositioned to enhance safety and reduce infrastructure cost of maintaining the source inventory. As a general observation, actinide sealed sources can be categorized by disposition end states, which are:

1. If the material characteristic and activity is sufficiently desirable - reuse or recycle (either direct reuse or as research/development feed stock)

2. If the material item is not sufficiently desirable to merit retention, the material can be declared as a waste and direct disposal as low-level waste or transuranic (TRU) waste

3. Stabilization and disposal as high-level waste

4. Interim storage as non-defense TRU waste.

This paper estimates the volume of actinide sealed sources currently managed as nuclear materials that may be disposed at the Waste Isolation Pilot Plant (WIPP) as TRU waste.

Table B-1 provides a breakdown of the actinide sealed source inventory data by isotope utilizing data acquired during the 1998 Nuclear Materials Integration project and currently maintained by the Nuclear Material Stewardship Program's Nonactinide Isotopes and Sealed Sources Management Group (NISSMG). The WIPP end state limits individual waste containers (Department of Transportation Type 7C) to 12.4 curies (Ci) (^{239}Pu) or 200 fissile gram equivalents (FGEs). For this estimate, Table 1 is divided by isotope and further subdivided into three distinct categories:

Table B-1. Actinide-sealed source inventory data by isotope.

Actinide Ci	No. of Sources	Total Ci
Pu-238 > 12.4	108	16435.83
1 > Pu-238 < 12.4	195	533.3385
Pu-238 < 1	234	3.01
Pu-238 Total	428	16972.18
Pu-239 > 12.4	10	538.937
1>Pu-239 >12.4	62	148.706
Pu-239 <1	5164	40.77
Pu-239 Total	5247	728.413
Am-241 > 12.4	2	130.267
1 > Am-241 > 12.4	32	116.066
Am-241 < 1	1750	18.93
Am-241 Total	1784	265.263
Am-243 > 12.4	0	0
1 > Am-243 > 12.4	1	1.198
Am-243 < 1	50	1.71
Am-243 Total	51	2.908

1. Number of items that meet or exceed the 200 ^{239}Pu FGEs per 55 gallon drum (12.4 Ci)
2. Number of items that contain 1-12.4 Ci
3. Number of items less than 1 curie.

Discussion by Isotope

^{239}Plutonium

There are 10 items (at Lawrence Berkley National Laboratory, the Idaho National Engineering and Environmental Laboratory, at the Savannah River Site (SRS), and at the Rocky Flats Environmental Technology Site) larger than the allowable 200 FGE limit per 55-gallon drum in the NISSMG inventory (greater than 12.4 Ci), four of these items also exceed the 20.15-curie limit per standard waste box limit. All 10 items hence cannot be disposed at WIPP unless there is some degree of processing performed to further subdivide the activity per drum. For the four large sealed sources disposal as part of the “can in can” program at SRS appears to be the most logical solution when these sources become excess to current program needs. The remaining six items are candidates for WIPP, but could also be included in the “can in can” program. Reuse as MOX feed due to the high purity of the materials is a possible option for all these materials.

There are 62 items in the NISSMG inventory are between 1 – 12.4 Ci, of these 21 likely do not have a defense program pedigree. The remaining 41 items are potential candidates for WIPP disposal. Using the 12.4 curie limit per 55 gallon drum and taking no credit for consolidation this equates to only 41 additional 55 gallon barrels.

Of the remaining 5,175 items (40.77 Ci) represented in the NISSMG inventory, a large fraction 93 % are low-level waste candidates.

The worst-case scenario for the number of shipments to WIPP assuming there are no economies for “centralized consolidation” and including non-defense, TRU is presented in Table B-2.

Table B-2. Pu-239 shipments to WIPP.

^{239}Pu	55 Gallon Drum	Standard Waste Box
Items greater than 12.4 Ci	37	6
Items greater than 1curie and less than 12.4 Ci	62	0
Items less than 1curie (assumes consolidation on shipping site)	45	0

If the total inventory of NISSMG ^{239}Pu inventory (~728 ci) is compared to the 795,000 Ci that is included in the WIPP performance assessment, the obvious conclusion is the ^{239}Pu will not have a significant impact.

^{241}Americium

There are two items larger than the allowable 12.4-curie limit per 55-gallon drum in the NISSMG inventory. One of these has 18.6662 Ci of activity and could be disposed as TRU waste in a standard waste box. The other has over 117 Ci, making it a difficult item to dispose at WIPP without repackaging. Logical pathways include the “can in can” SRS process or due to the high purity of the material reuse as feed material for commercial neutron or actinide sources.

There are 32 items in the NISSMG inventory are between 1 – 12.4 Ci, of these 14 likely do not have a defense program pedigree. The remaining 18 items are potential candidates for WIPP disposal. Using the 12.4-curie limit per 55 gallon drum and taking no credit for consolidation this equates to only 18 additional 55 gallon barrels.

Of the remaining 1750 items (18.93 Ci) represented in the NISSMG inventory, a large fraction, 76%, are low-level waste candidates.

The worst-case scenario for the number of shipments to WIPP assuming there are no economies for “centralized consolidation” and including non-defense TRU, is presented in Table B-3.

Table B-3. Am-241 shipments to WIPP.

^{241}Am	55 Gallon Drum	Standard Waste Box
Items greater than 12.4 Ci	10	1
Items greater than 1curie and less than 12.4 Ci	32	0
Items less than 1curie (assumes consolidation on shipping site)	51	0

If the total inventory of NISSMG ^{241}Am inventory (~18.93 Ci) is compared to the 488,000 Ci that is included in the WIPP performance assessment, the obvious conclusion is the ^{239}Pu will not have a significant impact.

^{238}Plutonium

There are 428 items in the NISSMG inventory, 108 of these are larger than 12.4 Ci and 195 items are between 1 – 12.4 Ci and contain 16,969 Ci of activity. Recycle options exist for all of these items, LANL and ORNL are both actively pursuing any excess ^{238}Pu for use in the future NE missions.

The remaining 234 items have 3.01 Ci of activity and 86% are likely candidates for low-level waste disposal. The remaining 37 items have 3.00 Ci of activity.

The worst-case scenario for the number of shipments to WIPP assuming there are no economies for "centralized consolidation" and including non-defense TRU, is presented in Table B-4.

Table B-4. Pu-238 shipments to WIPP.

^{238}Pu	55 Gallon Drum	Standard Waste Box
Items greater than 12.4 Ci	0	0
Items greater than 1curie and less than 12.4 Ci	0	0
Items less than 1curie (assumes consolidation on shipping site)	27	0

^{243}Americium

There are no items larger than 12.4 Ci in the NISSMG inventory and there is only one item between 1 – 12.4 Ci and it likely has no defense pedigree. The remaining 50 items only have 1.71 Ci of activity. Generally, the isotope production program at ORNL is willing to take all ^{243}Am for reuse as feed materials to their isotope production program.

The worst-case scenario for the number of shipments to WIPP assuming there are no economies for "centralized consolidation" and including non-defense TRU, is presented in Table B-5.

Table B-5. Am-243 shipments to WIPP.

^{243}Am	55 Gallon Drum	Standard Waste Box
Items greater than 12.4 Ci	0	0
Items greater than 1curie and less than 12.4 Ci	1	0
Items less than 1curie (assumes consolidation on shipping site)	9	0

Conclusions

Even though there are 7,510 sealed actinide sources in the NISSMG inventory, this does not represent a large number of 55-gallon drums or a significant increase in the total amount of activity permitted in the WIPP performance assessment. The worst-case estimate of drums resulting from actinide sources is 274 drums and 7 waste boxes.

Planned Future Activities

If Goal 3: Optimize TRU [transuranic] waste system operations, item 3. “Identify and evaluate alternatives to current treatment, characterization, transportation and disposal issues (e.g., centralized disposal characterization at WIPP)” of the *National TRU Waste Management Plan* is implemented these estimates can be greatly reduced.

Defense Transuranic Versus Non-defense Transuranic

Approximately 30% of the ^{239}Pu and ^{238}Pu sealed sources in the NISSMG inventory likely do not have a defense programs legacy. About 20% of the ^{241}Am and 30% of the ^{243}Am appear to not have a defense programs legacy.